Adults with traumatic brain injury (TBI) often have word retrieval problems (Barrow, et al., 2003; 2006; King, et al., 2006a; 2006b; Levin et al., 1981). Pattern of these difficulties has not been clearly delineated. Impaired confrontational naming frequently has been identified as a predominate symptom (Barrow et al., 2006; Capruso & Levin, 1992; 2000; Sarno, 1980, 1984; Ylsivaker et al., 2001). Adults with TBI produce a remarkable amount of superordinate errors, possibly reflecting problems in accessing basic level target responses. These errors appear to result in retrieval of the category label as compensation (Hough et al., 1997; Murdoch & Theodoros, 2001). General organizational deficits in categorization and sequencing also may contribute to this pattern (Adamovich, 2005; Hough, 2008; Hough, et al., 1997).

The Interactive Activation (IA) Model and Node Structure (NS) Theory depict the language system as a network of hierarchically organized and interconnected nodes comprising semantic, phonological, and motor programming systems (Burke et al., 1991; 2000; Burke & Shafto, 2004; Rastle & Burke, 1996; Stemberger, 1985; in press). Nodes are activated in an all or none fashion, priming all connecting nodes and spreading in parallel to nodes at higher and lower levels. During error-free word finding, activation of propositional nodes occurs, priming lexical nodes that prime phonological nodes. The lexical node for an intended word is activated if it receives more priming than another node (priming summation). The word receiving the greatest amount of activation inhibits other words.

Individuals with TBI may fail to retrieve a word because of periodic “noise” in the system, attributed to activation level or transmission deficit. Frequency of occurrence may influence consecutive nature of retrieval errors. The observation of one naming error begetting another error has been alluded to but not examined relative TBI (Goodglass, 1993; Goodglass, et al., 2001; Hough, 2006; 2007; 2008). Furthermore, word retrieval deficits have been examined, but episodes or periodic nature of errors has not been systematically analyzed. Thus, purpose of this investigation was to examine episodes of retrieval failure in adults experiencing TBI after motor vehicle accidents (MVA).

Method

Thirty adults (22M, 8F) with TBI participated. All were greater than two months post-injury (Table 1). Initial head injury severity for all was less than 10/15 on the GCS. All participants had a period of post-traumatic amnesia (PTA) at injury determined by the Galveston Orientation and Amnesia Test (GOAT). Currently, all had passed a hearing screening, were right-handed, native English speakers, and functioning at levels 6-8 on the Ranchos Los Amigo Levels of Cognitive Functioning Scale (Hagen, Malkmus, & Durham, 1979). All were administered the *Scales of Cognitive Ability for Traumatic Brain Injury* (SCATBI; Adamovich & Henderson, 1992) to determine extent of cognitive impairment (Table 2).

Participants were administered the *Test of Adolescent/Adult Word Finding* (TAWF) (German, 1990), a standardized battery for examining word retrieval skills in different linguistic contexts and organized into 6 subtests: Picture Naming: Nouns; Picture Naming: Verbs; Sentence Completion; Descriptive Naming; Category Naming; and Comprehension. The test was administered and scored according to

procedures outlined in the test manual. All participant responses were audio-taped for additional verification.

Of the 30 participants, 22 obtained TAWF standard scores below 85, indicating presence of a psychometrically-based word retrieval deficit (Table 3). Only data for these 22 participants were analyzed relative to episodes of retrieval failure. An episode is defined as consecutive occurrence of word retrieval errors. Data for the 22 participants were categorized using number of times word retrieval failures occurred:

- Followed by a correct response
- On 2 consecutive items followed by correct response
- On 3 consecutive items followed by correct response
- On 4 or more consecutive items

Results

Results are presented relative to word retrieval failure pattern based on consecutive and episodic nature of error occurrence on the TAWF. The 22 participants were classified according to 3 retrieval failure patterns (Hough, 2008).

Pattern 1: Fleeting word retrieval failures

- Large percentage of errors are isolated occurrences.
- At least 50% of episodes of retrieval failures occurred on single responses; number of 4+ consecutive retrieval failures fell within first standard deviation below the mean based on these 22 participants
- Percentages for single word retrieval failures exceeded 2 plus 3 consecutive error percentages.
- Less than 4 instances of 4+ consecutive retrieval failures

Pattern 2: Clustered word retrieval failures

- At least 40% of retrieval failure episodes occurred on 2 and 3 consecutive responses
- Number of 4+ consecutive retrieval failures fell within first standard deviation below the mean for the 22 participants
- Less than 4 instances of 4 or more consecutive word retrieval failures

Pattern 3: Extended word retrieval failures

- At least 30% of retrieval failure episodes occurred on 4 or more consecutive word retrieval failures
- Number of 4+ consecutive retrieval failures exceeded one standard deviation above the mean for the 22 participants
- At least 5 instances of this type of retrieval failure per participant

Based on classification patterns and data inspection, fifteen of the 22 participants displayed Pattern 1. The other 7 exhibited Pattern 3. Pattern 2 was not observed for any participant (Table 4). Table includes TAWF standard scores and four categories for number of word retrieval failure episodes, converted to percentage of occurrence for a particular error pattern. Mean and standard deviation are provided for actual number of times word retrieval failures were committed on four or more consecutive stimulus items because these data were used in definitions for patterns of word retrieval failure.

Discussion

Strength of Pattern 1 in this sample is evident in the high number of participants (15) exhibiting this pattern. For these particular individuals, over 75% of their word finding errors were fleeting in nature. Occurrence of four or more consecutive errors was rare. Furthermore, single (1) item retrieval failure percentages noticeably exceeded their 2 plus 3 and 4+ consecutive error percentages. The other 7 participants exhibiting retrieval deficits showed profiles of Pattern 3. These particular individuals had lowest scores on the TAWF of all 30 participants, suggesting a significant relationship between TAWF standard scores and retrieval pattern. However, further analysis is needed to confirm this hypothesis.

Naming task did not influence participant performance. Participants showed patterns of retrieval failure regardless of particular naming task on the TAWF. Word difficulty relative to frequency of occurrence also was not of consequence.

Relative to the IA Model and NS Theory, most adults with TBI appear to exhibit word retrieval deficits due to variances and intermittent disruption in activation or transmission relative to retrieval. Individuals exhibiting the Fleeting Pattern may experience intermittent disruption in activation and transmission processes whereas individuals showing the Extended Pattern have more prolonged disruption in these processes. Factors such as resource allocation, cognitive effort, and semantic organization, may differentially influence processes underlying retrieval skills relative to overall cognitive-communicative impairment (Adamovich, 2005; Gillis, 1996; Murdoch & Theodoros, 2001; Ylsivaker et al., 2001). These factors should be explored when considering the basis of processing deficits associated with TBI. Although this report is preliminary, episodes of retrieval failure analysis may assist in understanding mechanisms underlying word retrieval impairment after TBI.

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Table 1. Demographic data for TBI participants

	Age	Education	Months PI
Mean:	31.13	14.07	10.23
S.D.:	9.59	1.97	6.40
Range:	18-53	11-18	2-32

Education: years
Months PI: Months post-injury

Table 2. Severity of impairment for TBI participants

	PTA*	GOAT Scores*	SCATBI+
Mean	18.73	70.17	83.53
SD	12.37	8.27	16.84
Range:	1-48	60-85	58-113

PTA: post-traumatic amnesia in days determined by GOAT
GOAT: Galveston Orientation and Amnesia Test based on maximum score of 100
* Represents severity at initial injury.
+ Standard scores represent overall severity at time of study.

Table 3. Participant scores on the Test of Adolescent/Adult Word Finding (TAWF)

Participants	TAWF SS	TAWF PR
1	94	34
*2	58	1
*3	80	8
*4	70	2
*5	70	2
6	93	33
*7	52	1
*8	73	4
*9	71	3
10	90	27
11	96	41
*12	65	7
*13	55	1
14	90	24
*15	70	2
*16	75	5
*17	80	10
*18	73	4
19	93	32
*20	70	2
*21	75	5
*22	71	3
*23	80	8
24	97	45
*25	65	7
*26	78	5
*27	58	1
28	94	34
*29	70	2
*30	73	4
Mean:	75.97	11.9
SD:	12.7	13.99
Range:	58-97	1-45

SS: standard score
PR: percentile rank
*Participant has identified word retrieval deficit (Standard Score <85 on TAWF)

Table 4. Percentage of occurrence of 1, 2, 3, and 4+ consecutive word retrieval failures and error patterns on the *TAWF*

Subjects	*TAWF* SS *	1	2	3	4+
Fleeting:					
3	80	83**	17	0	0 (0)***
4	70	67	28	6	0 (0)
5	70	72	17	11	0 (0)
8	73	81	13	0	6 (1)
9	71	76	18	0	6 (1)
15	70	74	20	6	0 (0)
16	75	80	11	9	0 (0)
17	80	85	10	0	5 (1)
18	73	72	20	8	0 (0)
20	70	68	18	8	6 (1)
21	75	70	21	9	0 (0)
22	71	73	18	5	4 (1)
23	80	82	16	2	0 (0)
26	78	78	14	8	0 (0)
30	73	75	13	7	5 (1)
Extended:					
2	58	57	9	4	30 (5)
7	52	39	20	9	32 (6)
12	65	60	6	4	30 (5)
13	55	40	24	3	33 (7)
25	65	55	10	5	30 (6)
27	58	45	15	3	37 (7)
29	70	52	13	3	32 (6)
					Mean: 2.18
					S.D.: 2.67

* TAWF SS: Test of Adolescent/Adult Word Finding Standard Score

** Information expressed in Percentage of Error

***Number in parentheses represents actual number of occurrences of error type.